Soil Treatability Study

Energy Technology Engineering Center • U.S. Department of Energy

# *Phytoremediation Study*

Dr. Yarrow Nelson

Matt Poltorak

Michael Curto and Peter Waldburger

California Polytechnic State University

College of Engineering
CAL POLY

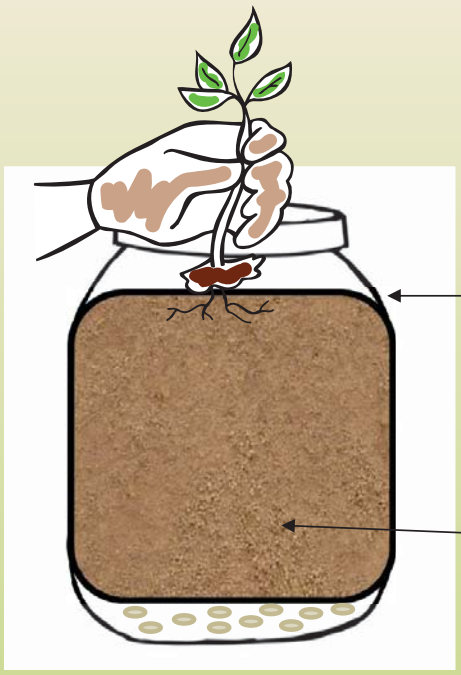
U.S. DEPARTMENT OF ENERGY

# Phytoremediation: Use of plants for remediation of contaminated soil

## Step 1: Field Screening

Photo: Mark Osokow

## Step 2: Greenhouse “microcosms”



# Phytoremediation Study Overview

- Study Plan: Approved
- Selected candidate species for screening
- Collected plants for screening analyses
- Plant propagation for microcosms
- Greenhouse microcosms
  - Collected soil for greenhouse microcosms
  - Currently setting up microcosms in the greenhouse

# 12 candidate species identified growing in study plots

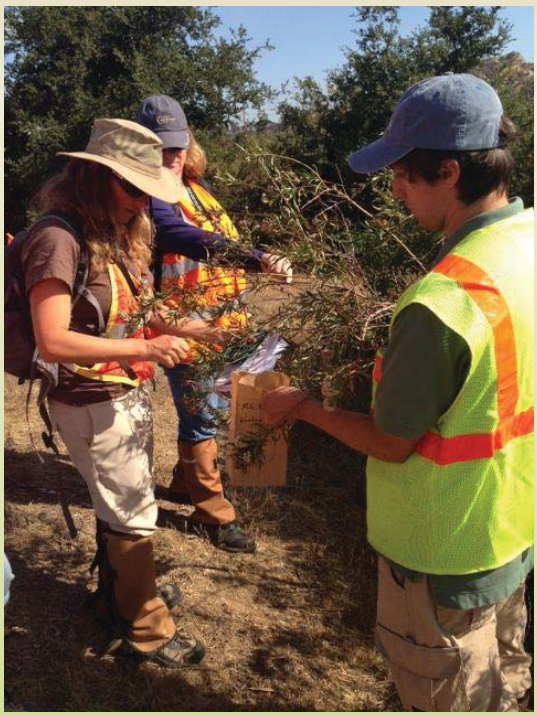
| Plant type | Scientific Name | Common Name |
|---|---|---|
| Grasses | *Elymus glacus* | Blue Wildrye |
| | *Stipa cernua* | Nodding Needlegrass |
| | *Bromus hordeaceus* | Soft Chess |
| | *Bromus madritensis* | Red Brome |
| Forbs | *Hirschfeldia incana* | Summer Mustard |
| | *Asclepias fascicularis* | Narrowleaf milkweed |
| | *Sambucus nigra* | Blue Elderberry |
| | *Malosma (Rhus) laurnia* | Laurel Sumac |
| | *Baccharis salicifolia* | Mule-Fat |
| | *Ericameria palmeri* | Palmer Goldenbush |
| | *Baccharis pilularis* | Coyotebush |
| | *Eriodictyon crassifolium* | Thickleaf Yerba Santa |

# Plant propagation for microcosms

- Collected seeds and tested germination (3x)
- Collected plant cuttings and attempted to root (2x)

# Plant propagation for microcosms

## --> Seed collection



Seed collected from plants in Area IV for propagating plants in greenhouse experiments (3 collection dates)

- May 29, 2013
- August 8, 2013
- November 4, 2013

# Seed germination test (Nov/Dec, 2013)

| Scientific Name | Common Name | Seed Germinated? |
|---|---|---|
| *Elymus glacus* | Blue Wildrye | Yes |
| *Stipa cernua* | Nodding Needlegrass | Yes |
| *Bromus hordeaceus* | Soft Chess | Yes |
| *Bromus madritensis* | Red Brome | Yes |
| *Hirschfeldia incana* | Summer Mustard | Yes |
| *Asclepias fascicularis* | Narrowleaf milkweed | No |
| *Sambucus nigra* | Blue Elderberry | No |
| *Malosma (Rhus) laurnia* | Laurel Sumac | Yes |
| *Baccharis salicifolia* | Mule-Fat | No |
| *Ericameria palmeri* | Palmer Goldenbush | Yes |
| *Baccharis pilularis* | Coyotebush | No |
| *Eriodictyon crassifolium* | Thickleaf Yerba Santa | No |

# Plant propagation from cuttings (Nov/Dec, 2013)

| Scientific Name | Common Name | Cuttings Collected? |
|---|---|---|
| *Elymus glacus* | Blue Wildrye | No |
| *Stipa cernua* | Nodding Needlegrass | No |
| *Bromus hordeaceus* | Soft Chess | No |
| *Bromus madritensis* | Red Brome | No |
| *Hirschfeldia incana* | Summer Mustard | No |
| *Asclepias fascicularis* | Narrowleaf milkweed | No |
| *Sambucus nigra* | Blue Elderberry | Yes |
| *Malosma (Rhus) laurnia* | Laurel Sumac | Yes |
| *Baccharis salicifolia* | Mule-Fat | Yes |
| *Ericameria palmeri* | Palmer Goldenbush | Yes |
| *Baccharis pilularis* | Coyotebush | Yes |
| *Eriodictyon crassifolium* | Thickleaf Yerba Santa | Yes |

So far – very limited success for all cuttings

# Plant screening for contaminant uptake

January 15-17, 2014

| Scientific Name | Common Name | Date Sampled |
|---|---|---|
| *Elymus glacus* | Blue Wildrye | - |
| *Stipa cernua* | Nodding Needlegrass | - |
| *Bromus hordeaceus* | Soft Chess | - |
| *Bromus madritensis* | Red Brome | - |
| *Hirschfeldia incana* | Summer Mustard | Jan 2014 |
| *Asclepias fascicularis* | Narrowleaf milkweed | Jan 2014 |
| *Sambucus nigra* | Blue Elderberry | Jan 2014 |
| *Malosma (Rhus) laurnia* | Laurel Sumac | Jan 2014 |
| *Baccharis salicifolia* | Mule-Fat | Jan 2014 |
| *Ericameria palmeri* | Palmer Goldenbush | Jan 2014 |
| *Baccharis pilularis* | Coyotebush | Jan 2014 |
| *Eriodictyon crassifolium* | Thickleaf Yerba Santa | Jan 2014 |

# Collected foliage, roots and soil to test for chemical uptake

Foliage

Roots

Root Zone Soil

# Plant screening status

- First sampling completed January 15-17, 2014
  - Collected at least one specimen of each forb species
  - Currently awaiting analytical results
- Duplicates and controls to be collected ASAP
- Grasses to be sampled after rains & grass growth

# Greenhouse microcosms

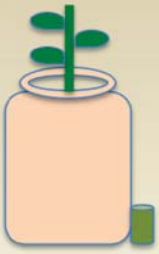
- Collected soil for greenhouse microcosms
  - Approximately 390 kg soil collected on January 16, 2014
  - Collected from Sub Area 5B, 17$^{th}$ St Pond area
  - Site selected for mixture of chemicals at moderate concentrations

# Greenhouse microcosms

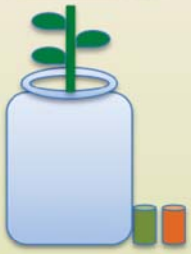
- Currently preparing soil for microcosms: sieving and mixing to ensure that all microcosms start with the same chemical concentrations.
- Waiting for analytical results so we know which plants to plant in the microcosms

# Greenhouse microcosms

Fertilized* Microcosm
Three Species



Sterilized‡ Microcosm
(fertilized*)
Only one species



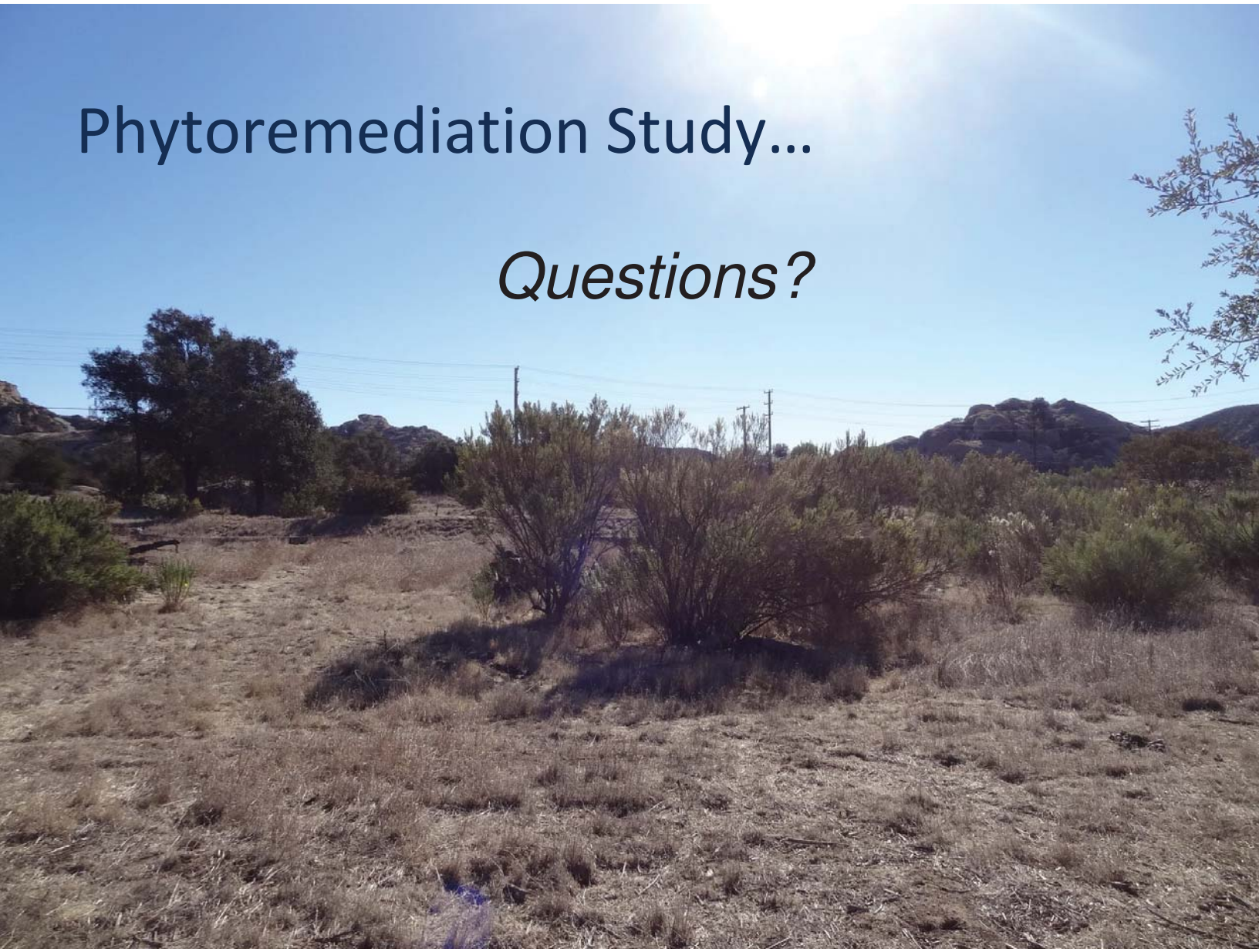
Fertilized* Microcosm +
Chelating agent
Only one species

Unplanted Microcosm
(fertilized*)

Unfertilized Microcosm
Only one species

Sterilized ‡ Unplanted
Microcosm (fertilized*)

*: All amendments will be analyzed for chemicals before use in microcosms
‡ : Sterilized by licensed facility
70 total microcosms: 40 primary microcosms (30 planted, 10 unplanted) and 30 planted spares


Phytoremediation Study…
*Questions?*